Name _____

The Earth Quakes

Have you ever felt the earth move under your feet?

The solid earth? Not quite! An earthquake is the movement of a part of the planet's crust. They often occur along the lines of faults or the edges of crustal plates. There are three kinds of faults that are found in the crust.

- **Normal faults** are breaks in the crust that are at a slanted angle. The pieces of crust pull apart or **diverge**, and one side slips down. The Sandia Mountains in New Mexico and the Grand Tetons are examples of mountains created along normal faults.

- When the plates push or **converge** into each other, **reverse faults** may occur. Blocks of crust are pushed so that one side of the fault is pushed up to hang over the crust on the other side of the fault. Strong, deep earthquakes may occur along these faults. Examples of mountains formed in this manner are found in Glacier National Park.

- **Strike/slip faults** occur when plates slide against each other. The most famous fault of this sort in the United States is the San Andreas Fault in California. Earthquakes occur when the forces built up are released.

Enormous pressures from Earth's mantle push the crustal plates. But they lock against each other, and sometimes do not move for a very long time. When they do, all this energy is released. That makes a massive quake.

The energy of an earthquake takes the form of vibrations or **seismic waves** that carry the energy from the **focus** or origin of the earthquake underneath the surface to other parts of the earth. There are two kinds of waves:

A. Primary waves (P waves) are the fastest waves of energy moving through all areas of the earth, solid and liquid. They can compress and expand the ground, much like sound waves compress and spread apart sound waves in the air. You can remember these as "push" waves.

B. Secondary waves (S waves) occur after the P waves. They vibrate from side to side as well as up and down. S waves travel more slowly and cannot move through areas that are completely liquid. The surface of the crust and structures on it may shake violently when S waves reach the surface. You can remember these as "shake" waves.

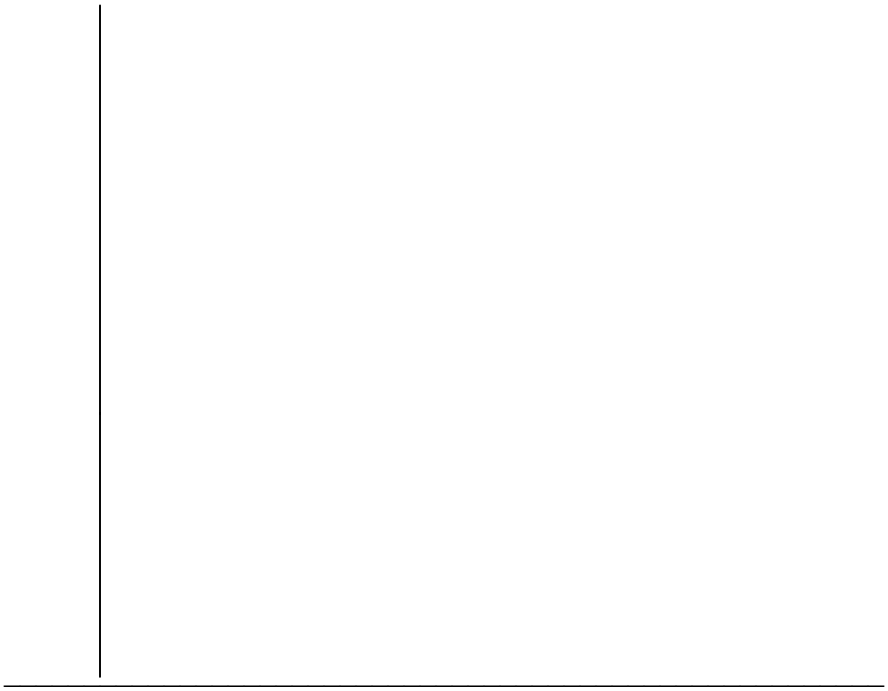
Seismologists around the Earth measure the intensity of the seismic waves as they reach the surface. After studying the data about the seismic waves, scientists can pinpoint the focus of the earthquake. Eventually scientists hope they can predict earthquakes instead of just studying them after they occur.

Earthquake intensity is measured on two different scales. The **Richter scale** shows how much energy an earthquake has, while the **Mercalli scale** shows how much damage it does. A very powerful earthquake in a barren desert might do less damage than a less powerful earthquake in a crowded city. The following table shows how many earthquakes of each magnitude occur in an average year.

Magnitude	**Number of quakes per year**
8.0 and higher	1
7.0-7.9	18
6.0-6.9	120
5.0-5.9	800
4.0-4.9	6200
3.0-3.9	49,000
2.0-2.9	365,000

Make a bar graph, using the Richter scale information above, to show how many earthquakes of different intensities occur each year.

The Annual Occurrence Of Earthquakes Of Varying Intensities

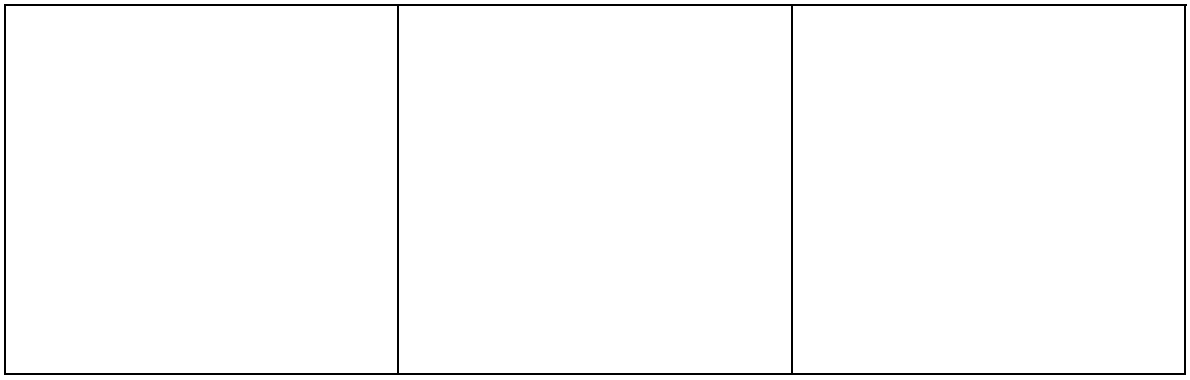


Making Models to Increase Your Understanding
Procedure:

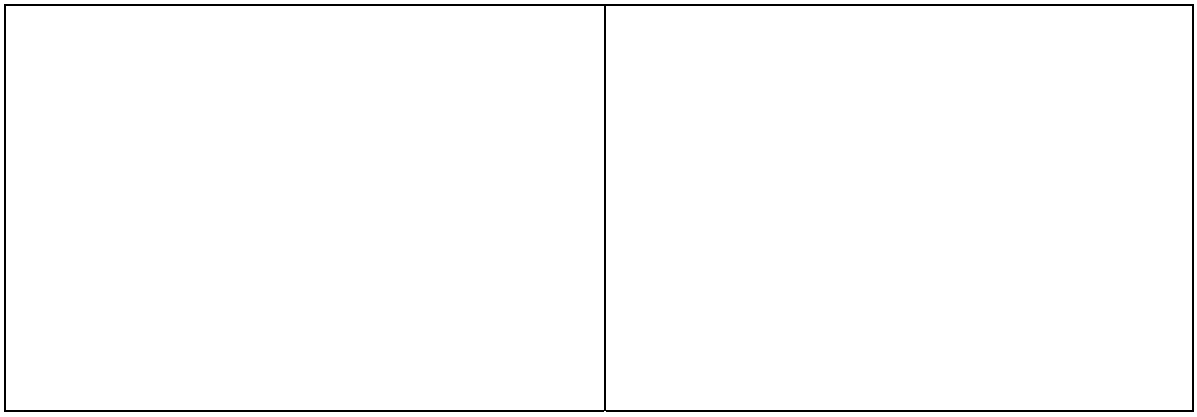
1. Using the materials as given to you by your teacher construct models of the three types of faults and the resulting changes in the land. Begin by making three levels of rock. (You can use any three colors of flat clay.) Put these layers on top of one another. Make the land a little uneven, like a hill and a valley. Then use frosting to paint on a stream. (Make sure your water flows downhill.)

   Next, use a plastic knife to cut your land cleanly.
   - Make a cut that slants as it goes down, to show a normal fault. Let part of your land slip down.
   - Show a reverse fault by pushing part of your land up to form a mountain. Use your hands to mold the clay to show how the lifted part might weather over time.
   - Finally, let one part of your land slide against the other to show a strike/slip fault.

   Watch what happens to the stream for each kind of fault. Draw and label each type of fault in the boxes below. Show the colors of clay and the stream.



2. Draw what happens when a Slinky is used to model a P wave and an S wave.



Quake Hits Michigan!

Lansing, September 2, 1994

Michigan residents were startled yesterday, as the earth shook beneath them. An earthquake registering 3.4 on the Richter scale rocked our normally steady state. Geologists from Michigan State University were the only ones who were not surprised to feel the tremors.

Kazuya Fujita, an MSU geology professor, explained to the Lansing State Journal: "In Michigan, there are cracks in the basement rock that run northwest to southeast. The earthquake occurred along a similar but as yet unmapped fault. When you apply a stress, it moves a little bit."

What Fujita called "a little bit" seemed massive to the residents who grabbed for the nearest stable object. On the Mercalli scale, which measures damage to structures and living things, the quake measured a V on a Roman numeral scale from I to XII. Geologists speculated that the epicenter was over 10 km underground.

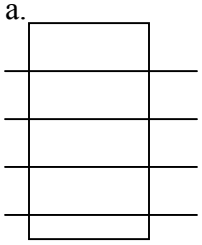
Luckily, fearful Michiganders probably will not quake again soon. The last one this state experienced measured 4.7 on the Richter scale, and was centered in Coldwater in 1947, and on average occur only once every fifty years.

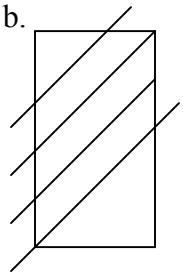
It's Your Turn

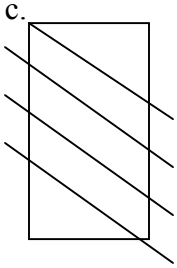
After reading the article, pick the best answer to each question below. Circle the letter of the best response. Then underline or highlight where in the article you found the information for your response.

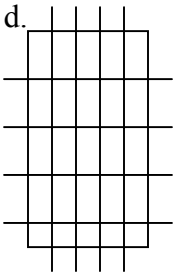
1. The Michigan earthquake originated
    a. near the ground surface
    b. by a fault
    c. 10-15 km underground
    d. all of the above

2. Cracks in the lowest rock under Michigan run in these directions:

a. 

b. 

c. 

d. 

3. During every century in Michigan we get earthquakes about

    a. 1 time
    b. 2-3 times
    c. 5 times
    d. 10 times

4. A 1994 Michigan quake registered

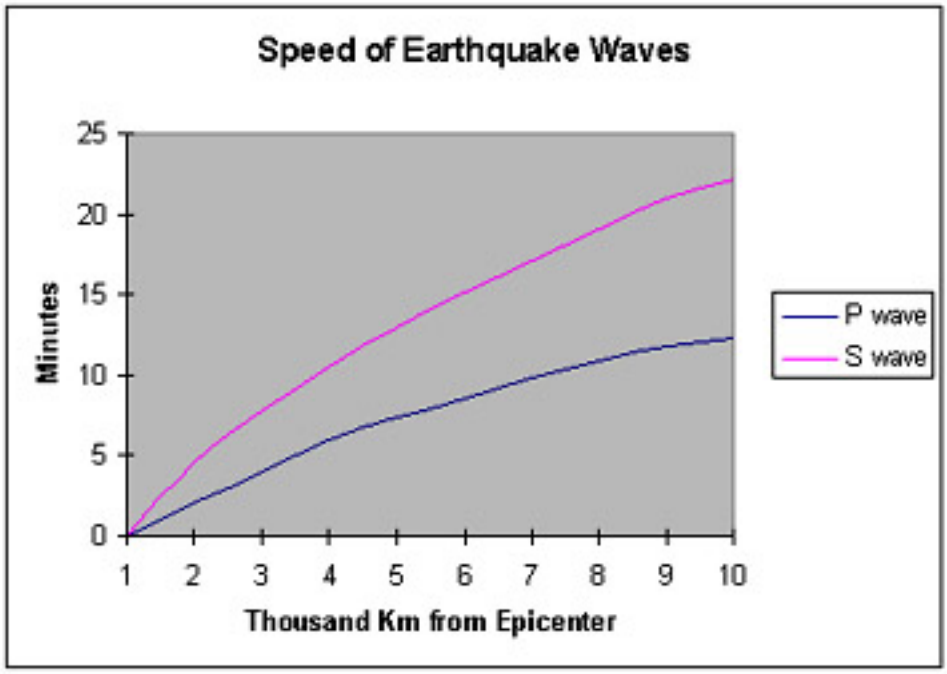
    a. 8.3 on the Richter scale
    b. 3.4 on the Richter scale
    c. XII on the Mercalli scale
    d. I on the Mercalli scale

5. Scientists gathered helpful earthquake information about this quake from

    a. the weather reports
    b. dogs and cats that behaved strangely before the earthquake
    c. people who felt it
    d. satellite pictures

Locate the Epicenter

When you feel a P wave, an S wave is on its way. Look at this graph of time and distance:



1. If you were 2000 km from the epicenter and felt a P wave, how long would you wait until the S wave hit?_____

2. Suppose there were three students on an Internet chat when an earthquake occurred. Each of them measured the time between the P and the S wave. Can you tell how far each is from the earthquake's epicenter?

City	Delay	Distance
Tokyo	4.2 minutes	
Sydney	6 minutes	
Hawaii	10 minutes	

3. Get a world map. Use a compass to mark off a circle with a radius equal to the distance you've filled in above.
   Where do the circles intersect? _____That is the epicenter.